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REMARKS ON SCHULZE'S SYSTEM OF DESCRIPTIVE TERMS.¹

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One cannot systematically describe a number of species or in fact properly record observations especially upon isolated species or groups without the aid of a convenient nomenclature and a generalized, topical scheme of work. The invention of such a system obliges one to make a more or less complete classification of the parts of any form, and this is a most efficient aid to thorough observation and a check upon hasty, inconsequent or unsystematic description.

Such remarks are apparently superfluous and even supercilious, but no one can work with new methods or try to find in scientific literature reliable data with regard to any of the invertebrates without being continually confronted with positive evidence that in the effort to place new species on record, many naturalists have lost sight of the main aim of descriptive work. The fixed habit of considering a new species as a discovery of such importance, that the describer's name must forever remain attached to it, is perhaps necessary, but it has loaded scientific research with an enormous mass of badly constructed records.

¹This paper with the exception of the introductory remarks was published in *Biologisches Centralblatt*, XIII, Nos. 15-16, August, 1893, as *Bemerkungen zu Schulze's System einer deskriptiven Terminologie*. It has been thought advisable to have it published in English.

One of the most remarkable characteristics of the literature of this century in zoölogy and paleontology is the great contrast between the careless, inadequate, descriptive text of many large costly works and the excellent plates and other accompanying illustrations. There are a number of these books in which there is a wide difference between the scientific record made by the author and his artistic efforts or those of his draughtsman, the former being often inconsequent and unworthy of companionship with the latter. I refrain from giving examples for the simple reason, that they are within the experience of every student, and there would be no compensating advantage in exciting useless antagonisms. An attempt to construct a properly systematized topical scheme of work would have forced such authors to name and describe most of the principal regions and parts of the anatomy and to follow out a similar scheme in the description of each species, thus minimizing the irregularity and vexatious incompleteness of their observations.

One of the marked characteristics of the day in natural science is the effort to give greater accuracy to descriptive nomenclature. Professor B. G. Wilder² was the pioneer in America, and although his efforts were for many years unappreciated, they are now beginning to bear fruit. Wilder and Gage's *Anatomical Technology* (1882) laid the foundation of the movement which has just been reinforced in Germany by a very able paper from Franz Eilhard Schulze³ in which he lays down some general principles for the construction of terms that ought to be carefully read by every naturalist.

The details of his scheme are in brief as follows :

He divides organic bodies into ; (I) die Synstigmen, Centrostigma of Haeckel (*στειγμα* meaning point) having a single imaginary centre to the body. This point he proposes to call "centrum," parts in the centre "centran," approximate parts are "central" or "proximal," those which lie toward the cen-

²A partial revision of anatomical nomenclature, with especial reference to that of the brain. *Science*, II, 1881, pp. 122-126. 133-138.

³Bezeichn. d. Lage u. Richtung im. Thierkörper. *Biol. Centralb.*, XIII, No. 1, 1893.

tre "centrad" or "proximad," those lying away from the centre "distal" or "distad," parts external or on the periphery "distan." Any part at right angles to the imaginary radii of the body or to the surface, he proposes to call "tangential" as long as they are external or "paratangential," when they are internal. Thus there may be tangential parts or distan, distal, proximal and central, paratangential parts, and they may be distal from the centrum or proximal when not central or centran.

Professor Simon Gage of Cornell in a letter to Dr. Wilder comments upon the use of "centran" as follows. "One of Schulze's principal points over what is ordinarily given is the suggestion of the termination "an" for the absolute centre, ventral surface, dorsal surface or aspect, etc. Barclay in his book, pp. 168-173, considers this and uses for this purpose the ending "en" as "centren, dorsen, dextren, sinistren," etc.

"The natural development of these ideas would have been to make a distinction between internal and external, using the termination "an" for internal parts which are centran or axian and leaving "en" for the designation of such as are peripheral. It is, however, evident as suggested by Dr. Wilder, that the termination "en" is more suitable for the designation of internal parts, on account of its derivation and common use, whereas "an" is in line with the terminations "al," "ad" and not in conflict with usage. It seems to me that Schulze is not wholly consistent in his use of the termination "an," and that following Wilder's suggestion, it would be much better to say centren and use centran for any external points which might be established in the polar axis of the body."

The class of bodies referred to as Synstigmen are to be found exclusively among Protozoa or their corresponding cellular elements among Metazoa, and Schulze's term is defective in that it takes no notice of the large numbers, especially among Infusoria, which have a spiriform arrangement of parts or of the entire body, often also more or less complicated with bilateral asymmetry.

Although it is obviously desirable that the assumption of an imaginary centre should be made in cases which have no

organic centrum, it will be considered questionable in the description of tissue cells or the bodies of the Protozoa, whether the nucleus should not be considered as the centrum. Schulze thinks that in such cases a distinction should be made and an additional compound term framed which would express the difference between the artificial and natural points or axis, etc. Thus the nucleus would be the "nucleo-centrum" however excentric its position. Undoubtedly in this, as in other cases, it is of advantage to make comparisons between the imaginary morphic centre and the organic centre, since while these are often the same they are not coincident in many forms and the use of a double set of terms will oblige observers to note such phenomena in their descriptions. Nevertheless one cannot say without experience in practical application whether a double set of terms would be advantageous or merely burdensome. (2). Die Syngrammen (*γραμμή* meaning line) the Centraxonia of Haeckel, bodies elliptical cylindrical, etc., pyramidal, etc., which may be considered as having their parts arranged around an imaginary central axis but having all sides equal. This axis he calls "principal axis" both ends are styled "termini," the surfaces immediately around the termini are "terminan" and the direction toward them "terminad."

Centrum, centran, centrad, are used as before for parts lying in the principal axis or in that direction. "Axian" is employed for parts in the principal axis, when near to that line "proximal,"⁴ when directed toward it "axiad," the region away from the principal axis is "distal," the direction is "distad" and the surface or periphery is "distan."

All planes or parts lying in planes going through the principal axis are "meridian," all parallel with these "parameridian." The parts lying in the plane passing through the centre at right angles to the principal axis are "transversan," and

⁴The use by Schulze of "proximal" as a synonym for "central" is open to serious objection. Proximal, proximad as synonyms of central, centrad, are not essential to his scheme, and these words are already in use as general descriptive terms applicable to any neighboring parts. It is, therefore, obviously disadvantageous to try to give them a more restricted meaning. The restriction of distal, distad, distans, to the body has similar objections and is not sustained by usage.

the planes parallel to this are "paratransversan." If the suggestion were adopted, all parts lying internally in these planes would be meridian and transversen, and the points on the periphery also in these planes would be meridian and transversan.

He intimates that there are oral and "aboral" planes in the paratransversan planes, but does not advocate the use of the terms oran, orad, and aboran and aborad as desirable for those bodies having the mouth in what may be called the terminan paratransversan plane, and the anus or base in the opposite plane.

Among Porifera one can assume a central axis, and it is possible to distinguish the oral and aboral ends or what may be considered as corresponding to them, the excurrent apertures (or so-called oral openings) and the attached base. But the incurrent apertures, the digestive sacs, the tissues and the spicules of the skeleton are normally arranged in concentric layers, which cannot be referred to any system of imaginary planes parallel with the principal axis. There is in these forms no organic element by which a meridian plane can be determined, they are exclusively concentric.

The same remarks apply also to the Hydrozoa and Actinozoa and more or less to all of the animals included under the old term, Radiata, whose parts are normally arranged in concentric layers cut by radiating lines and planes. If Schulze's system had taken note of such general morphic characters it would have been more complete. The meridian plane can be organically determined in most of these organisms, but this primitive division of the body is not carried out in the structures of the sides, these have no organic lateral parts which can be advantageously compared with any supposed parameridian planes. They and the tissues of the body all lie in concentric tubular conical or spherical surfaces secondarily intersected by radiating lines and planes. Schulze's system of planes takes no notice of these facts, but his meridian and transversan planes can be used with advantage to indicate the existing bilateral elements in these structures. The main objection to his system appears to be that it is better fitted for use among

"Bilaterien," that is for Mollusca, Worms, Myriapods, Insects and especially Vertebrates, than for the simpler organisms Protozoa, Porifera, Hydrozoa, Actinozoa, in which this element of symmetry is absent or more or less obscured.

Professor Wilder has already used "peripherad" as the antithesis of "centrad" and according to Schulze's system peripheran could be used for the distal surface in general. Thus the mesenteries of the actinozoa extend peripherad from the principal axis or the median plane.

It is also questionable whether a good topical classification of such animals as Actinozoa and Echinodermata ought not to recognize an intermediate region between the central and distal regions. There would be just as great a difficulty in defining a central region and a distal or peripheral one as in limiting the use of these terms to two regions separated by a third, which might be termed the extra-central with reference to the axis or extra-median when used with reference to the corresponding plane.

(3). "Die Sympeden oder Bilaterien," Zeugiten oder Centrepipden of Haeckel. These bilateral bodies have three axis. The "perlateral" axis is described as "isopolar" by Schulze, probably in allusion to the organic similarities of its poles. "Equiradial" would be equally good description on account of the equal lengths of the radii of the axis. The other is the dorso-ventral axis and is what he calls "heteropolar" and this is apt to be also inequiradial. The principal axis is the longitudinal axis, also described as "heteropolar" and apt to be also inequiradial, estimating from the supposed organic centrum. All in the principal axis is "axian," the neighborhood is "axial," the direction "axiad," or one may also use proximal, proximad, farther from it everything is "distal," and the direction away from this axis is "distad."

The two ends of the principal axis are respectively "rostral" instead of "cephalic" or "oral" or "proral" (Prora, prow of a vessel) and the tail end or the other end, whether distinguished by a tail or not, "caudal" instead of "aboral."⁵

⁵ Schulze subsequently gave his nomenclature with illustrative figures in Verhandl. d. Anat. Gesellsch., May 1893, and Verhandl. d. deutsch. Zool. Gesellsch., May 1893. In this paper and in the discussion following this last a.

The surface of the rostral end is "rostran" and the surface of the caudal end is "caudan." The direction toward these are respectively "rostrad" and "caudad."

In a letter from Prof. Gage to Dr. Wilder which has been forwarded to me, the former very justly observes that "Schulze discards 'cephalic' although he adopts caudal. Cephalic is certainly a more natural opposite of caudal than is rostral, the word he proposes in its place. Then cephalic has been and is used a great deal in English and considerably in German, and the use is increasing."

The main objection to this in my opinion, is that it applies to the vertebrata better than any other type and fails with the simplest forms of these. Among *Ascidia*, for example, there is perhaps a rostral extremity, but there is no caudal extremity in the adults. There is an aboral region, but the oral region is central or centran. While one therefore might make rostral, rostran and rostrad work well, some other term than caudal should be employed for the opposite pole. It seems contrary to all rational usage to employ terms having a definite meaning like cephalic and caudal to bodies that have no head, nor representative oral opening, and no tail.

Whenever in bilateral animals the mouth is at the extreme pole of the principal axis, I can see no objection to the use of oral, oran, orad, but when it is not there rostran, rostral and rostrad are highly appropriate. When the mouth is external and ventran, or lies out of the principal axis on any surface, as it is in a number of types, additional accuracy may possibly be given to the terminology if both rostral and oral planes or regions were recognized. At any rate this suggestion might be tested.

Schulze uses "dorsal" and "ventral" for the entire halves of the body respectively, the extreme surfaces are "dorsan" and "ventran," the direction toward them "dorsad" and "ventrad." The perilateral axis has "dextral" and "sinistral" number of other terms synonymous with rostral and caudal, viz. atlantal and sacral, oral and aboral, proral and prymnal, actinal and abactinal were brought forward, even "Alpha ende" and "beta-ende" and the accompanying "alphan, alphan, alphan," "betal, betan, betad" were proposed for the two ends of the principal axis in bilateral animals.

halves, the ends are "dextran" and "sinistran,"⁶ the direction toward them "dextrad" and "sinistrad."

The intersection of the axis is as before "centrum," the neighborhood "central," the direction "centrad." All the parts lying in the imaginary plane passing through the principal and ventro-dorsal axis are "median," the neighborhood is "medial," the more distant region on either side is "lateral." The direction toward the median plane is "mediad," direction toward the side is "laterad." Medial does not appear to be any improvement upon Barclay's term "mesial" or Wilder's modification "mesal" for the same plane. The latter in fact is preferable both on account of prior use and brevity. The extreme outer lateral parts or surfaces are "dextran" and "sinistran" like the ends of the axis, the direction toward these "dextrad" and "sinistrad." Thus the two halves of the body are dextral and sinistral but the hands and feet are dextran and sinistran, the arms and legs extended dextrad and sinistrad of the dextran and sinistran surfaces of our bodies, and the right elbow is dextrad of the shoulder but mediad of the wrist.

This statement according to Wilder and Gage should be that "the right elbow is distad of the shoulder but proximad of the wrist," mediad and mesal being restricted to the trunk or used only for the general statements with regard to the limbs. Usage derived from Barclay would apply proximal and distal wholly to the appendages, distal being toward the free end and proximal at or toward the attached end. Wilder and Gage use these terms in this restricted sense and Comstock gives them an identical meaning. Butschli in the discussion quoted above in note also maintained that these terms should be applied only to appendages and parts outside of the mass of the body. That Schulze had no such limitations in mind when framing his terms seems to be settled by his suggestion to use proximal as a synonym for central, and

⁶Wilder and Gage use the term "aspect" in the same sense as Schulze words ending in "an," or Barclay's ending in "en"; thus there is the cephalic aspect and ventral dorsal, lateral and sinistral aspects. The strongest objection to these terms is the fact that they are not mononymic, whereas Schulze's terms fulfil this requirement.

his application of *dorsan* to the peripheral parts and the similar use of terms ending other in "an."

Comstock in his "Guide to Practical Work in Entomology"⁷ says that *dorsad*, *ventrad*, *cephlad*, etc., indicate direction in parallel lines having infinite extension. "In other words these terms must be used in a way analogous to that in which we use right and left." Lines which converge according to small explanatory wooden model kindly sent me by Prof. Wilder, are described by him as "*caudo-laterad*" when directed from the head end to the sides, *cephalo-mesad* when in the opposite direction, "*dorso-latero-cephalad*" when diverging from the caudal extremity toward the dorsum and side and so on.

The plane passing through the principal and perilateral axis is termed by Schulze the "*frontal*" plane (a poor word as acknowledged by Schulze). This divides the ventral from the dorsal regions, but Schulze seems to get into trouble here and omits the usual list of terms for neighborhood. These must be *dorso-frontal* and *dorso-frontad*, very awkward terms and about as inconvenient as *ventro-frontal* or *ventro-frontad*, but *dorsan*, *dorsad*, and *ventran*, *ventrad* for the outer parts, come into line again without difficulty. It would appear more natural to designate this as the perilateral or lateral plane or the *tergo-frontal* plane. This would enable one to designate the neighborhood on either sides as *frontal* and *tergal* and the directions toward the plane as *frontad* and *tergad*, any part in the plane itself would then be *tergo-frontans* or *frontens*, etc. *Tergo-frontal* would not interfere with the normal use of these terms on either side of it and be also in accord with *dorsal*, *dorsad* and *ventral*, *ventrad*, for the ventral and dorsal regions respectively, and would designate the duplex relation of this plane passing as it does between two distinct regions of the body.

The third plane passing through the dorso-ventral and perilateral axis, is the "*transversal*" dividing the rostral from the caudal regions of the body; the parts lying in this plane are "*transversan*" and the direction "*transversad*"; rostral, ros-

⁷Ithaca, University Press, 1882, p. 9.

tran, rostrad, caudal, caudan and caudad also work well for the remoter parts. All planes lying parallel to any of these within the body are distinguished by the prefix "para."

Wilder and Gage have already recommended and now habitually use many of the terms also adopted by Schulze, but their system was tentative and did not aim at completeness. They, however, have used effectively "ental" and "ectal" terms not noticed by Schulze. Thus "the dura (matter)" is "ectad" of the brain but "entad" of the cranium. A part may be divided by cutting either ecto-ental or ento-ectad." There is also another application of words derived from ἐξτος and ἐντός which seems an obvious advantage. Ectal, ectans and ectad can be of great use if limited exclusively to parts that protrude from the surface of the body, like the appendages in Vertebrata, Crustacea, the spines of Echinoidea, the arms of Crinoidea, the tentacles of Actinozoa and the like. Parts that stand out from the distan or terminan, rostran or caudan, dorsan or ventran surfaces of the body. If this were done the limbs would all be described as ectal of dextran and sinistran surfaces, the articulations of the body would be "ectad" or "entad" of those surfaces or their origin, if penetrating deeper might be designated by an appropriate term according to the topical terms already employed, central, proximal or distal. All the minor divisions of the ectal parts could then be referred to the surfaces of the body. Thus the bases of the spine in Echinus would be ectad of the body but proximad of its surface, while the termination would be distan with relation to the same surface, and it would have its own centrum and central region, principal axis, and so on.

In applying these words to a deeper seated part as to the radiating spines of Radiolarian or the threads of the stalk of a Hyalonema the use of "ental" to designate the part inside of the distan surface of the body would not entail confusion, since it would be used in direct connection with the description of the spine or threads. The stalk of Hyalonema in the most complicated example would be ental in origin, arising in the distal. It would be better to say the oral or actinal part of the central axis, pass through the centrum and

aboran regions and extend ectad, spreading out during its progress into a support suitable to anchor the body of the sponge in the mud below. The spines of *Xiphacantha* would be ento-ectal (extending from the centrum to the distans⁷ surface and then ectad) having their origin in a central mass, possessing radiating spines on the distan surface and passing ectad of these to a variable distance.

Professor Gage objects to this in the following words "It seems to me the suggestions with reference to ectal, etc., are not happy. Proximal and distal seem to me to express nearness and remoteness of appendages to the part from which they arise. That may be reference to a limb or the trunk taken as the origin. For example, the arms and legs are appendages of the trunk, their distal ends being the hands and feet and the attached ends the proximal. So just as properly, in accordance with the established use of proximal and distal, the attached end of the hair is its proximal end while the free end is distal. This is true whether the hair is on the trunk or an appendage. I think the use originally made of ectal and ental by yourself (Wilder) the best one, the fundamental idea is in the compounds Ectoderm and Entoderm."

These criticisms coming from such a source and appealing to the derivation of the words are consistent with the Barclayan system and would be very convincing but for one thought that makes me hesitate to abandon this suggestion until I can learn more from experience. If the terms ectal and ental are to be applied to parts without reference to their origin, but simply because they are external and internal, it is obvious that they cannot be restricted any more than the words, outside and inside. If one is describing a spine or appendage of any sort the surface is ectal, the inner part ental, but if one is describing the body with reference to its appendages, the spines are ectal or they may have parts within the body and these are ental. The limbs of the Vertebrata and Crustacea may be considered either with reference to the surface of the body or to the skeleton, but the stalk of a hyalonema and the spine of Radiolarian may originate from the centrum itself.

⁷ A better word here is peripheran.